Hunters Dam Site

The Hunters Dam site is located on Hunters Creek, about 9 miles southwest of the town of Willows in Glenn County. It extends from Section 17 through Section 5, T18N, R4W on the Logan Ridge 7.5-minute USGS topographic quadrangle map. Access to the dam site is via private roads. This dam would be constructed across three drainages that cut through the main sandstone ridge from west to east, creating three separate water gaps. From south to north, these are termed the Prohibition water gap on the south fork, the Owens water gap on the middle fork, and the Hunters water gap on Hunters Creek (Photo 30). The proposed dam would be a 230- to 260-foot high earthfill structure with a 14,000-foot crest length at an elevation of 540 feet.

Previous geologic work for the Hunters Dam site was limited to a brief assessment performed by DWR for the Klamath-Trinity Development Project conveyance system in the 1960s. The current Northern District investigation consisted of geologic mapping, and drilling and water pressure testing four diamond core drill holes at the Owens water gap (See Plate 8, Sheets 1 and 2).

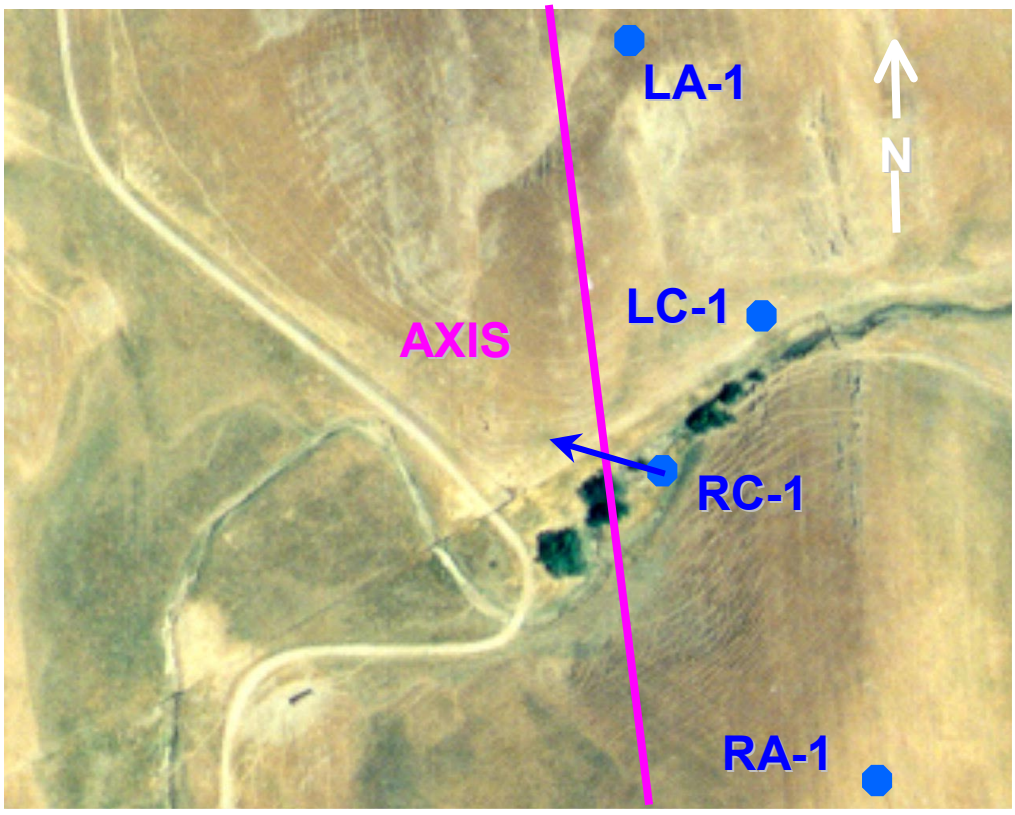

Photo 30. Aerial view of Hunters Dam site (Owens Component) and drill holes

Dam Site Geology

The dam site foundation comprises a ridge of Cretaceous sandstone and mudstone units. The beds strike slightly west of north and dip downstream 45 to 55 degrees east at the southern end of the dam and 55 to 65 degrees east at the northern end. The Boxer Formation, primarily mudstone with some sandstone interbeds, comprises the western side of the ridge and the upstream area of the dam foundation. The mudstones are generally covered by soil and colluvium and occupy topographic lows. The mudstone rarely outcrops except in road cuts, streambanks, or landslide scarps. The Venado sandstone member of the Cortina Formation, which is massive to bedded sandstone with minor mudstone, forms the ridge. Good exposures of the bedrock are found in the drainage channels where they cross the ridgeline.

The ridge top is generally covered with thin soil, and the side slopes are mantled with colluvium. Quaternary alluvial deposits and Quaternary terrace deposits cover the bedrock locally with observed thicknesses of 5 to 15 feet along the stream channels. They are composed of sand, silt, and gravel, mantled by a clayey soil.

Plate 8 presents North District's reconnaissance-level geologic mapping. Plate 9 presents one geologic profile parallel to the dam axis (A-A), and one cross section each perpendicular to the Prohibition (B-B), Owens (C-C), and Hunters (D-D) water gaps. Detailed logging and photo documentation of the drill core is presented in Technical Memorandum A. Details of the water pressure testing are presented in Technical Memorandum B. Details of the piezometer construction and water levels are presented in Technical Memorandum C.

Bedrock Units

The majority of the dam foundation is composed of interbedded Upper Cretaceous sandstone and mudstone of the Boxer and Cortina Formations, forming a ridge that extends the length of the dam site (Photo 31). The foundation bedrock consists of about 65 percent mudstone and 35 percent sandstone.

These bedrock units were differentiated into mappable units (see Plate 8) as follows:

- KCVm - mudstone (70 to 100 percent) with sandstone of the Venado member of the Cortina Formation intervals (0 to 30 percent) up to five feet in thickness,

- KCVs - sandstone (70 to 100 percent), of the Venado member of the Cortina Formation with mudstone intervals (0 to 30 percent) up to five feet in thickness,

- KCVsm - interbedded mudstone (30 to 70 percent) and sandstone (30 to 70 percent) of the Venado member of the Cortina Formation,

- KBm - mudstone (70 to 100 percent) of the Boxer Formation with sandstone intervals (0 to 30 percent) up to 5 feet in thickness,

- KBsm - interbedded mudstone (30 to 70 percent) and sandstone (30 to 70 percent) of the Boxer Formation.

Photo 31. Boxer/Cortina Formation contact on ridge just SW of Hunters component.

The sandstone unit is light to medium olive gray in color when fresh, and yellowish brown when weathered. It is mostly a very fine to medium-grained well-sorted arkosic sandstone with a silty to clayey matrix. Bedding is massive to cross-bedded and outcrops in units ranging from less than a foot to tens of feet in thickness. It contains thin interbeds of siltstone and mudstone that range from laminar up to 5 feet in thickness. It is typically weathered at the surface. It is moderately to well indurated, moderately to slightly fractured, moderately hard to very hard, and strong. Internal structure is well developed in the areas of cross bedding and vague where massive. Calcite healing along fractures is common, with some pyritization.

Mudstone is the least resistant rock type in the area. The mudstone unit is dark gray to black in color when fresh and tan when weathered. Bedding is thinly laminar with thin sandstone and siltstone interbeds. It is brittle and slakes and weathers rapidly when exposed to air and moisture. It is moderately indurated to friable, moderately hard to weak, and closely fractured.

Unconsolidated Deposits

Unconsolidated deposits consist of Quaternary alluvium, stream terraces, colluvium, and landslides.

Quaternary alluvium (Qal) is located in the active stream channel of Hunters Creek and tributaries, and consists mainly of lean clay, silt, sand, gravel, cobbles, and boulders. It occurs along the channel sides and as discontinuous deposits in the channel. Deposits are estimated to range up to 5 feet in thickness. Deposits of Qal were too small to show on the map.

Two terrace deposits (Qt2 and Qt3) border the active stream channel both upstream and downstream of the dam axis. Qt2 is a broad flat surface 5 to 10 feet above the stream channel. Observed thickness ranges from 5 to 10 feet. Soil development is moderate. The upper part of this terrace is clayey silt with increasing clay content downward. Some gravel lenses are exposed along the sides of the incised stream. In places there is a clay bed near the base of the observable deposit. The color of the upper 3 feet is very dark, grayish brown, then grading lighter downward to brown. This terrace may correlate with the Modesto Formation as mapped by Helley and Harwood (Calif., Sacramento Valley 1985). Qt3 is a higher topographic surface 10 to 20 feet above the stream channel and has some slope. In places the Qt2 surface is set into the Qt3 surface. Where exposed, the Qt3 deposits are silty clay with some rounded gravel. The Qt3 surface merges with the colluvium along the ridge front.

Colluvium occurs at the base of the steeper slopes and consists of clayey silt and sand with angular rock fragments. This deposit ranges from 2 to 10 feet in thickness.

Several minor landslides have been mapped at or near the proposed dam axis. Twelve of these occur within the dam footprint. Three of the landslides are associated with a lineament that traverses the ridge just north of the Prohibition water gap. The rest of the landslides are mostly within the mudstone unit of the Boxer Formation on the west side of the ridge or within a mudstone unit that occurs stratigraphically above the second major sandstone bed of the Venado on the east side of the ridge. Most of these are earth flows and debris slides. Most are surfical, with thicknesses of 2 to 5 feet, and should be easily stripped and not affect the proposed dam foundation.

Structure

The primary structural feature at the Hunters Dam site is the northerly striking, east-dipping homoclinal bedding of the Great Valley sequence (Photo 32). Local attitudes vary in strike from N3°W to N15°W and bedding dips in an eastward direction, mostly from 45 to 55 degrees at the south end to 55 to 65 degrees at the north end.

Photo 32. Southern view of the Hunters component of Hunters Dam site

Lineaments

Several lineaments have been identified in the bedrock at or near the dam site. Associated with these lineaments are narrow zones of gouge and sheared rock.

One lineament crosses the dam alignment just north of the Prohibition water gap. The lineament trends southwest to northeast. If this lineament is a fault, the sense of movement would be right lateral, with an apparent offset of the Boxer/Cortina contact and major sandstone units of about 300 feet and the fault plane would be near vertical.

A second lineament crosses the dam alignment about a quarter of a mile north of the Hunters Creek water gap (Photo 33). The lineament trends southwest to northeast. If this lineament is a fault, the sense of movement would be right lateral, with an apparent offset of the Boxer/Venado contact and the second major sandstone in the Venado of about 150 feet; and the fault plane would be near vertical.

Some shearing and minor displacements have been observed in the north abutment at the Owens water gap but a thorough ongoing, continuous lineament is not mappable at the scale of this investigation.

No drill holes have been placed to explore these lineaments in the subsurface.

Photo 33. Lineament truncating sandstone beds north of Hunters component

Joints

At least two separate joint sets have been mapped in the area of the dam site. The primary and most distinctive jointing strikes roughly east-west and has a near vertical dip (75 degrees north to 75 degrees south). This jointing is expressed in the exposures of the Venado sandstone in all three of the water gaps. Secondary jointing exists at N20°W to N45°W with dips of 20 to 45 degrees west.

Foundation Conditions and Exploration

Hunters Dam site was mapped by DWR's Northern District in November and December 1999. Mapping was easiest along the central sandstone ridges with generally good exposure of outcrops. At least two suspected southwest-northeast trending faults intersect the proposed foundation. The rock at Hunters Dam site should provide a good foundation for the proposed dam with mostly minor stripping.

Hunters Component

At the Hunters gap the left abutment is moderately steep to about elevation 390 feet then flattens along the ridgeline to the north. There is a gully extending to the north along the less resistant beds between the two major sandstone units of the Venado member. The right abutment slopes steeply to about elevation 420 feet before the slope decreases. A massive sandstone unit underlies both ridges. The

beds strike N7°W and dip 50 to 70 degrees to the east. The dominant joint direction is about east-west and dips from 87 degrees to the north to 74 degrees south. A secondary joint set strikes northwest and dips about 40 degrees southwest. There are several minor landslides on the downstream side of the right abutment.

Hunters Creek joins with a tributary in the center of the channel section. The streams are intermittent with no flow in the late summer and fall and are incised 5 to 10 feet into the lower terrace deposit.

Vegetation is light throughout the gap, consisting of annual grasses and forbs except for three or four trees in the upstream channel.

About 2,400 feet north of the Hunters Creek gap the ridge is crossed by a lineament that offsets the Boxer/Cortina contact to the right about 150 feet. This feature has not been drilled or trenched to establish its true character. At least one spring associated with this lineament is within the dam footprint.

Owens Component

At the Owens gap the left abutment is very steep to about elevation 480 feet before it begins to flatten. A massive sandstone unit is exposed along the downstream face. The right abutment slopes steeply to about elevation 400 feet. The bedding strikes N7°W and dips 50 to 65 degrees east. The dominant joint direction is about east- west and dips 65 to 87 degrees south. A secondary joint set strikes north-west and dips 35 to 55 degrees west.

The tributary of Hunters Creek that crosses this gap carries a very low flow through the summer. The channel is incised into the lower terrace about 5 to 10 feet.

Vegetation is light throughout the gap, consisting of annual grasses and forbs except for a few trees in the upstream channel.

Some sheared rock has been observed on the face of the left abutment, but no displacement has been observed in this area.

In spring 1998 DWR's Northern District contracted with All Terrain Drilling to provide drilling and testing services as part of this investigation. A CME-850 drill rig was used to drill four HQ diamond core holes at the Owens component on the Middle Fork of Hunters Creek during the 1998 field season. An angle and a vertical drill hole were drilled in the channel, and one vertical hole was drilled on each abutment (See Plate 8, Sheet 1). Table 18 summarizes the foundation conditions. Both abutment holes required cementing toward the beginning of drilling due to extremely high water takes. Water pressure tests were performed on these fractured and weathered intervals prior to the cementing of the holes. Drilling then commenced to the bottom of the hole, and water pressure tests were run from the bottom of the drill hole up to the cemented interval.

TABLE 18 – Colusa Reservoir Project, Hunter's Dam Site Foundation Conditions (total area of Dam Site Footprint = 18,017,600 feet^2)

FEATURE	SURFICIAL/BEDROCK GEOLOGY (by area in feet^2)*	CLEARING ESTIMATES	STRIPPING ESTIMATES	WATER LEVELS	GROUTING ESTIMATES	STRUCTURAL REMARKS
Hunters Dam Axis Length = 14,000 feet. Max Footprint Length = 16,000 feet. Min Elev. = 270 feet. Max Elev. = 540 feet.	Surficial Qls = 41,000 feet^2 (<1%) Qt_1 = 1,720,800 feet^2 (10%) Qt_2 = 5,349,900 feet^2 (30%) Qc = 10,905,900 feet^2 (60%) Total Area = 18,017,600 feet^2 Bedrock KBsm = 28,400 feet^2 (<1%) KCVs = 3,047,500 feet^2 (17%) KCVsm = 6,951,600 feet^2 (39%) KCVm = 7,990,100 feet^2 (44%) Total Area = 18,017,600 feet^2 Therefore: Ss = from 4,218,800 feet^2 (23%) to 10,310,700 feet^2 (57%) Ms = from 7,687,500 feet^2 (43%) to 13,770,500 feet^2 (77%)	Entire ridge is covered only in annual grasses and shrubs. Very few trees occur along the drainage in each water gap.	Not Drilled	Not Drilled	Not Drilled	Two major lineaments cross the dam site, one just north of Prohibition gap and one north of Hunters gap. These features have not been drilled.
Hunters Component of Hunters Dam	Not broken out by component	Light vegetation. Annual grasses & Forbes	Not Drilled	Not Drilled	Not Drilled	Not Drilled
Owens Component of Hunters Dam DWR Drill holes LA-1 (located 590 feet north of channel on dam axis ~260 feet above channel), RA-1 (located 795 feet. south of channel on dam axis ~230 feet above channel) , LC-1(located on dam axis in channel), and RC-1 (located on dam axis in channel)	Not broken out by component	Light vegetation, Annual grasses, Forbes and a few sparse trees present.	On the left abutment the upper 10 to 15 feet of soil, colluvium, and intensely weathered rock can be stripped using common methods. An additional 27 to 47 feet of moderately weathered rock may need to be excavated. In the channel the upper 19 to 28 feet of soil, colluvium, and intensely weathered rock can be stripped using common methods. An additional 4 to 7 feet of moderately weathered rock may need to be excavated. On the right abutment the upper 9 feet of soil, colluvium, and intensely weathered rock can be stripped using common methods. An additional 50 feet of moderately weathered rock may need to be excavated.	Water surface elevations in LA-1 varied from 430.6 feet in July 1999 to 452.4 feet in Sept. 1999. Water surface elevations in RA-1 varied from 421.7 feet in Nov. 1999 to 425.1 feet in Nov.1988. Water surface elevations in LC-1 varied from 255.6 feet in July 1999 to 259.6 feet in Nov. 1998. Water surface elevations in RC-1 varied from 251.4 feet in Nov. 1999 to 254.3 feet in March 1999.	DWR drill hole Owens LA-1: high grout takes from 18 to 61feet and 86 to 179 feet. in zones of weathered and/or fractured Ss/Ms. The rest of the hole requires little to no grouting. DWR LC-1 shows high grouting takes from 34 to 77 feet. depths but none on the rest of the hole. DWR RC-1 shows no grouting take through entire hole. DWR drill hole Owens RA-1: high grout takes from 22 to 55 feet in a zone of intensely to moderately weathered and fractured Ss/Ms. There are also zones of high grouting requirement from 61 to 96 feet. and 133 to 166 feet in shear zones and fracturing. The rest of the hole requires little to no grouting.	Not Drilled
Prohibition Component of Hunters Dam	Not broken out by component	Light vegetation, annual grasses, Forbes & few trees.	Not Drilled	Not Drilled	Not Drilled	Not Drilled

Ss = Sandstone Ms = Mudstone Cgl = Conglomerate Qal = Quaternary Alluvium Qc = Quaternary Colluvium Qt_1 = Quaternary Terrace (lower) Qt_2 = Quaternary Terrace (upper) Fx = fracturing
*** Total Foundation Area of Damsite Footprint = 18,017,600 feet^2, therefore total Ss = from 4,218,800 feet^2(23%) to 10,310,700 feet^2 (87%); total Ms = from 7,687,500 feet^2(43%) to 13,770,500 feet^2(77%)**

Vertical drill hole LA-1 was drilled on the ridge top of the left abutment of the Owens component to a total depth of 252.1 feet. The upper 9.2 feet were augered through the weathered zone. From 9.2 to 58.8 feet, the hole drilled through 60 percent sandstone with 40 percent mudstone interbeds. From 58.8 to 140.6 feet, the hole drilled through 80 percent silty sandstone with 20 percent mudstone. From 140.6 to 216.0 feet, the hole drilled through silty mudstone. From 216.0 to 252.1 feet, the hole drilled through 50 percent sandstone and 50 percent mudstone. The hole encountered zones of fracturing at 11.4 to 11.6 and 13.0 to 13.2 feet in the upper part of the hole, and a zone of intense fracturing from 64.9 to 65.5 and 74.2 to 78.8 feet. A shear zone with slickensides was encountered at 112.0 to 113.0 feet and another at 163.2 to 165.2 feet. The zone between 197.5 and 216.0 feet contained many slickensides and fractures, some calcite healed and some with pyrite.

Vertical drill hole LC-1 was drilled in the drainage gap at the Owens component. It was drilled to a total depth of 203.3 feet. The upper 23.6 feet were augered through terrace deposits on the floor of the gap. There was no recovery from 23.6 to 28 feet. From 28.0 to 68.5 feet, the hole drilled through thickly bedded siltstone. From 68.5 to 88.3 feet, the hole drilled through 50 percent sandstone and 50 percent mudstone interbeds. From 88.3 to 110.5 feet, the hole drilled through 90 percent mudstone with 10 percent sandstone interbeds. From 110.5 to 123.3 feet, the hole drilled through 90 percent sandstone with 10 percent mudstone interbeds. From 123.3 to 163.5 feet, the hole drilled through 80 percent mudstone with 20 percent siltstone. From 163.5 to 173.3 feet, the hole drilled through 50 percent siltstone and 50 percent mudstone; and from 173.3 to 203.3 feet, the hole drilled through 80 percent mudstone and 20 percent siltstone. The hole encountered minor fractures and shears at 86.3 and 86.6 feet, and fractures with slickensides at 150.8 to 151.8 feet.

Angle drill hole RC-1 was drilled at a 45 degree angle toward the west, roughly perpendicular to the bedding. It was drilled to a total depth of 204.2 feet. The upper 23.4 feet were augered through terrace deposits on the floor of the gap. From 23.4 to 37.2 feet, the hole drilled through 60 percent sandstone and 40 percent mudstone. From 37.2 to 81.7 feet, the hole drilled through 80 percent mudstone with 20 percent siltstone interbeds. From 81.7 to 123.0 feet, the hole drilled through 80 percent sandy siltstone and 20 percent mudstone. From 123.0 to 204.2 feet, the hole drilled through 80 percent mudstone with 20 percent siltstone interbeds. The hole encountered fractures at 42.2, 43.7, 46.3 to 48 feet; and at 69.3 and 75.3 feet, the hole encountered fractures with slickensides.

Vertical drill hole RA-1 was drilled on the ridge top underlying the right abutment. It was drilled to a total depth of 248.6 feet. The upper 4.7 feet were augered through the weathered zone. From 4.7 to 8.1 feet, the hole drilled through 80 percent mudstone with 20 percent sandy siltstone interbeds. From 8.6 to 35.7 feet, the hole drilled through 80 percent sandstone with 20 percent mudstone interbeds. From 35.7 to 58.7 feet, the hole drilled through 50 percent sandstone and 50 percent mudstone interbeds. From 58.7 to 248.6 feet, the hole drilled through 80 percent mudstone with 20 percent sandy siltstone interbeds. The hole

encountered shear zones at 62.2 to 62.4, 63.1 to 63.4, 66.5 to 68.4, and 72.2 to 74.5 feet. Another shear zone with gouge and slickensides was encountered at 95.4 to 101.8 feet. From 135.0 to 142.1 and 149.6 to 156.0 feet, the hole intersected zones of intense fracturing with some slickensides. Rock quality designation data are summarized in Table 19.

Rock Strength

Samples of the core were taken from drill hole LA-1 from 51.5, 55.8, and 172.7 feet; from drill hole LC-1 from 29.6, 82.1, and 115.1 feet; from drill hole RA-1 from 13.5, 34.3, and 69.1 feet; and from drill hole RC-1 from 38.1 feet. These samples were taken by DWR's Project Geology and tested by DWR's Bryte Laboratory for specific gravity (SSD) and ultimate stress. Results are tabulated in Table 20.

Water Pressure Testing and Grouting

Drill hole LA-1 encountered weathering and fracturing of the sandstone and mudstone bedrock encountered from 9.2 to 61.3 feet accounting for high Lugeon values and semi-pervious permeabilities. Lugeon values ranged from 29 to 41, averaging 33, with patterns showing void-filling and dilation type characteristics. Permeabilities in this interval ranged from 0.62 to 1.24, averaging 0.84 feet per day. Zones from 179.0 to 185.9 feet and 216.0 feet to bottom of hole had zero grouting requirements and impervious conditions. The rest of this drill hole showed pervious permeability characteristics and high grouting requirements.

In drill hole LC-1 permeabilities are high, averaging 0.52 feet per day in the top 76.7 feet of this drill hole, indicating pervious conditions. Weathering and fractures along bedding planes account for these high values. Associated grouting requirements are also high in this zone, Lugeon values ranging from 23 to 34. From 76.7 feet to the bottom of the hole at 203.3 feet, semipervious to impervious permeability conditions exist. Lugeon analysis indicates dilation type patterns throughout this portion of the hole, which is regarded as a temporary feature, and no grouting required.

Drill hole RC-1 encountered sandstone with mudstone interbeds in the top 7-foot interval tested, and mudstone throughout the remainder of the hole. Testing indicates that permeabilities are low with an average of 0.02 feet per day, and ranging from impervious to semi-pervious conditions. With an exception of a Lugeon value of 1 in the top interval tested, from 30.0 to 42.0 feet, the remainder of the hole is tight, with a Lugeon value of zero, indicating that no grouting is necessary for this hole.

Drill hole RA-1 had intensely to moderately weathered sandstone with mudstone interbeds accounting for the high permeabilities and high Lugeon values

encountered in the top 35 feet of this hole. Lugeon values were over 100 in this zone; permeabilities ranged from 4.15 to 13.48 feet per day, and averaged 7.26 feet. With the exception of two shear zones, the rest of this hole is tight, with no grouting required, and impervious to semipervious permeability conditions (0.00 to 0.24 feet per day). Shear zones and fracturing encountered from 61.4 to 95.7 feet and 132.6 to 165.7 feet suggest dilation type Lugeon patterns, indicating that, although it is regarded as a temporary feature, these zones' grouting requirements are high (average Lugeon value of 8) and moderate (average Lugeon value of 5), respectively. Permeabilities in these two zones range from 0.19 to 0.25 feet per day (average 0.21 feet per day) and from 0.11 to 0.22 feet per day (average 0.17), respectively.

Table 19. Rock quality designation in DWR drill holes at Hunters Dam site (Owens component)

Agency	Drill Hole	Vert. Depth (feet)	Min. RQD*	Max. RQD*	Avg. RQD*	Description
DWR	LA-1	38 64	0	82	45	Poor
DWR	LA-1	64 109	48	100	72	Fair
DWR	LA-1	109 119	0	54	27	Poor
DWR	LA-1	119 189	66	100	88	Very Good
DWR	LA-1	189 214	0	46	19	Very Poor
DWR	LA-1	214 253	60	100	93	Excellent
DWR	LC-1	28 33	64	64	64	Fair
DWR	LC-1	33 58	96	100	99	Excellent
DWR	LC-1	58 63	0	0	0	Very Poor
DWR	LC-1	63 98	82	100	93	Excellent
DWR	LC-1	98 148	96	100	99	Excellent
DWR	LC-1	148 153	48	48	48	Poor
DWR	LC-1	153 203	86	100	98	Excellent
DWR	RC-1	23 27	28	28	28	Poor
DWR	RC-1	27 65	78	100	95	Excellent
DWR	RC-1	65 83	62	100	80	Good
DWR	RC-1	83 145	90	100	98	Excellent
DWR	RA-1	58 114	18	74	39	Poor
DWR	RA-1	114 133	75	90	85	Good
DWR	RA-1	133 159	0	46	18	Very Poor
DWR	RA-1	159 169	72	86	79	Good
DWR	RA-1	169 248	100	100	100	Excellent

Table 20. Drilling footage of Hunters Dam site (Owens component)

Drill site	Drill hole	Date started	Date completed	Drilled footage (feet)
Hunters Dam Site (Owens Component)	LC–1	August 3, 1998	August 6, 1998	203.3
	RC-1	August 10, 1998	August 17, 1998	204.2
	RA-1	Sept. 21, 1998	Oct. 1, 1998	248.6
	LA-1	Oct. 7, 1998	Oct. 22, 1998	252.1
	Total HQ diamond drill footage			908.2

LA = Left abutment drill hole
LC = Left channel drill hole
RC = Right channel drill hole
RA = Right abutment drill hole
DHPP = Drill hole power plant
DHS = Drill hole spillway
DHT = Drill hole tunnel
SSD = Sites saddle dams
AUG = Auger holes

Not enough site-specific data have been gathered to analyze the requirements for grouting along the rest of the dam alignment. Additional vertical core holes with water tests are required to better evaluate the subsurface conditions at this site.

Faults uncovered in the foundation may require some cleaning and excavation of weakened and sheared rock before the embankment is placed. These faults/shears, bedding, and jointing are potential seepage paths through the abutments and will undoubtedly require grouting. Therefore, for estimating purposes, a minimal amount of blanket grouting should be considered to seal near-surface fractures and joints.

Water Levels

Owens component drill holes LC-1, LA-1, RC-1 and RA-1 had piezometers placed in them after drilling. Water levels have been monitored since summer 1998. Water surface elevations in LC-1 varied from 255.6 feet (July 1999) to 259.6 feet (November 1998) (Photo 34). Water surface elevations in LA-1 varied from 430.6 feet (July 1999) to 452.4 feet (September 1999) (Photo 35). Water surface elevations in RC-1 varied from 251.4 feet (September 1999) to 254.3 feet (March 1999) (Photo 36). Water surface elevations in RA-1 varied from 421.7 feet (November 1999) to 425.1 feet (November 1998).

Photo 34. Vertical drill hole LC-1 of Owens component

Photo 35. Northern view of left abutment of Owens component

Photo 36. Southern view of right abutment of Owens component

Clearing and Stripping

The Hunters Dam site includes three water gaps, each with a channel and left and right abutments. In addition, there are about 10,000 feet of ridge to be covered by the dam that would not be included in a discussion of channel or abutment. The upstream and downstream toes of the dam parallel the ridge in the less resistant bedrock for the entire length of the dam. Deposits in the valleys include terrace and colluvium that will have to be stripped to depths of 10 to 15 feet. The ridges on both the upstream and downstream sides are very steep and will be difficult to access directly with earth-moving equipment.

Not enough detailed exploration has been performed to assess the clearing and stripping requirements over the entire 14,000 foot length of the dam. Generally the entire area is covered with annual grasses and forbs with light clearing requirements. There are a few trees along the channel in each water gap.

For the entire dam, 41,000-square feet of landslide deposits have been mapped. Most of these are small surface slumps and soil flows with thicknesses of 3 to 5 feet. There is one larger slide in the Prohibition gap with a thickness of 10 to 15 feet. There is 1.721-million square-feet of lower terrace deposits 5 to 10 feet thick and 5.35-million square-feet of upper terrace deposits including some colluvium 5- to 15-feet thick. The rest of the dam site, 10.877-million square feet, is covered by shallow soil or rock outcrops. The bedrock includes 23 percent to 57 percent sandstone and 43 percent to 77 percent mudstone.

Prohibition Component

At the Prohibition gap the left abutment has a moderate slope to an elevation of 400 feet then flattens along the ridgeline to the north (Photo 37). The right abutment slopes steeply to an elevation of about 480 feet before the slope flattens. A massive sandstone unit underlies both ridges. The beds strike N7°W and dip 50 to 55 degrees to the east. The dominant joint direction is about east-west and dips 75 degrees south. There are several minor landslides on the upstream side of the right abutment, and the largest landslide mapped, with up to three episodes of movement, occurs on the downstream side of the right abutment.

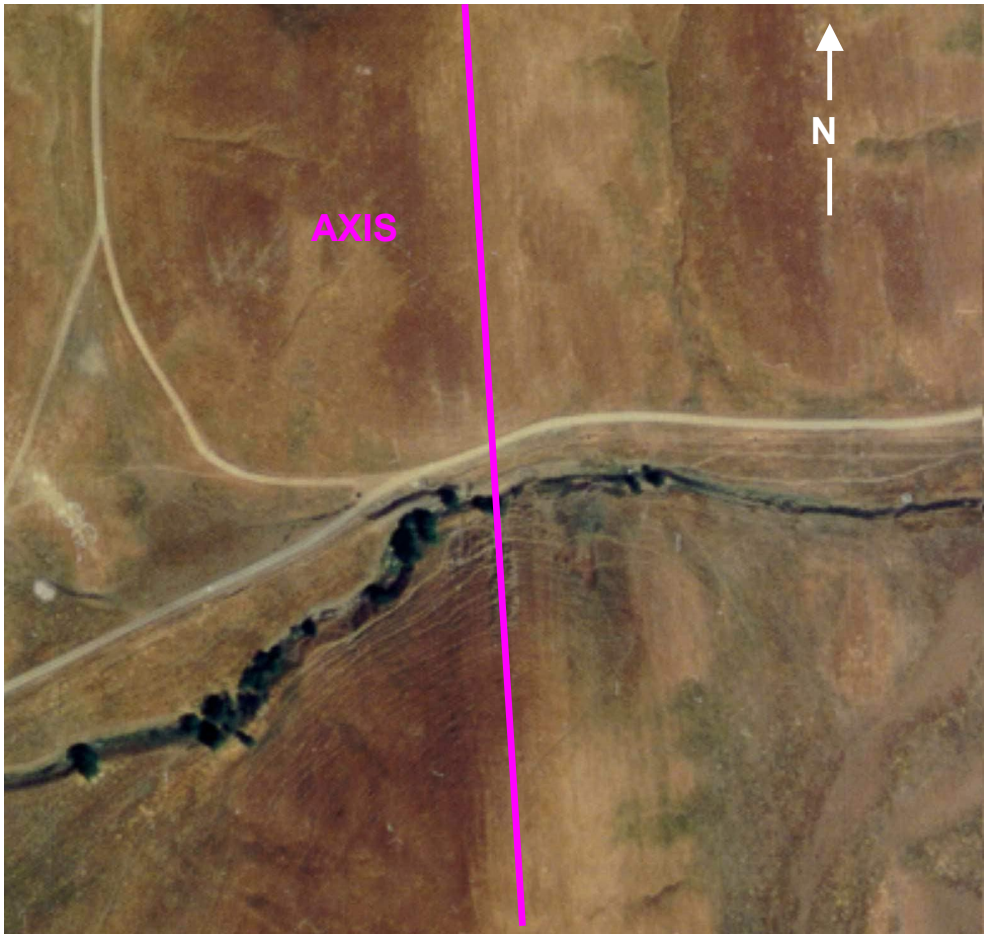

Photo 37. Aerial view of Prohibition component of Hunters Dam site

The tributary of Hunters Creek that crosses this gap carries a very low flow through the summer. The channel is incised into the lower terrace about 5 to 10 feet.

Vegetation is light throughout the gap, consisting of annual grasses and forbs except for a few trees in the upstream channel.

About 1,200 feet north of the Prohibition gap, the ridge is crossed by a lineament that offsets the Boxer/Cortina contact about 300 feet laterally. This feature has not been drilled or trenched to evaluate the recency of movement. Several small landslides occur along this lineament.

Conclusions and Recommendations

The Hunters Dam site has had only a reconnaissance-level geologic investigation and four drill holes at the Owens component. Two potential faults that cross the dam alignment have been mapped. Bedrock encountered during drilling appears to be adequate for the proposed foundations. The following work still remains:

- Map the dam site, especially two other major components, i.e., Hunters and Prohibition, in more detail.
- Drill and water pressure test Hunters and Prohibition.
- Drill and trench the two potential faults.